Could C-BSE be caused by genetically susceptibility and “monogastric” state of calf?

Keywords
C-BSE, Cattle, Calf, Susceptibility

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Introduction and Objectives
In November 1986, classical Bovine Spongiform Encephalopathy (C-BSE) was diagnosed for the first time in two different parts of England. The most common prion disease is called classical BSE (C-BSE) which is acquired and manifested after the consumption of contaminated meat and bone meal (MBM). Less common is atypical BSE (L-type and H-type BSE), both of which have distinct pathology and epidemiology from C-BSE.
By the end of August 2017, 190,675 BSE cases have been recorded throughout the world including the 96.83% cases (184,627) in the UK. BSE mainly affected cows aged between 21 months and 29.0 years (UK), making difficult to understand when they were infected. This long and variable incubation period also explains the small number of BSE male cases.
The goal of this paper is to explain the concentration of 96.83% of BSE world cases found in UK.

Materials and Methods
This study is mainly based on the data collected in the UK since the number of cases recorded (> 184,000) is definitely a reliable database. BSE case records are the outcome of passive and active surveillance. This does not change the quality of results as the active surveillance identifies BSE cases at the most in the six months before onset.

Results
During the 1980s, along with a change in rendering practice, there was a commercial advantage in using MBM, as the protein supplement, because of the escalating cost of soya and fishmeal. The inclusion rate of MBM in British animal feed rose from 1% to 12% over this period and MBM was fed to all categories of the cattle industry, included calves, in particular in dairy industry. By comparison, the inclusion rate in French cattle diets was typically 1.5%. Outside the UK, calves were not fed MBM tout court or very rarely.
In cattle, the major changes in the immunology and physiology of the intestinal tract occur when calf, so the age may well lead to (perhaps complex) age-related changes in susceptibility. The calf's rumen is relatively undeveloped at birth and during the first months of life, so protein in feed sources go directly to the abomasum and the small intestine. Dairy calves are usually reared away from their mothers and are given whole milk or proprietary milk substitute until weaning at 6 to 8 weeks old. In retrospect, it could be considered a huge experiment (no MBM *vs* MBM fed to calf) ended with 96.8% of the world cases of BSE in the UK and only 3.2% in the rest of the world. Observing the curve of BSE cases by year of birth in Figure 1, it is clearly evident the increase in cases from the beginning of the 80's.
In Figure 1, curiously, BSE cases by year of birth begin to decline after 1987, before the first ban of July 1988, in spite of the growing contamination in MBM. According a polinomial equation, based on the 1974-1987 period, the reported and estimated cases untill 1989 are indicated (Table 1). We would have had a peak of 96,838 cases instead of 28,035 reported cases in 1988. A logical and possible explanation could be the presence of a share of cattle genetically susceptible to C-BSE when calf, in the UK’s population. The yearly maximum of new infected calves was reached in 1987, even before MBM was banned. Then the share of C-BSE susceptible cows in production started to decrease and then the susceptible female newborns.

Conclusions
To explain the great anomaly of 96.8% of BSE world cases found in UK and the 1987 peak in BSE cases by year of birth, two hypotheses were introduced and motivated: 1) a genetically susceptibility in a share of bovine female population; 2) calves could be infected during the first months of life when fed contaminated feed, at least to the infectious level that was in the contaminated feedstuffs during mad cow crisis.
Right now, in the UK, unlike the rest of the world, the dairy cattle population could be considered almost genetically free from susceptibility to C-BSE, less the beef cattle.

Figure 1: Trends of BSE female cases by year of birth and death in the UK and bans.

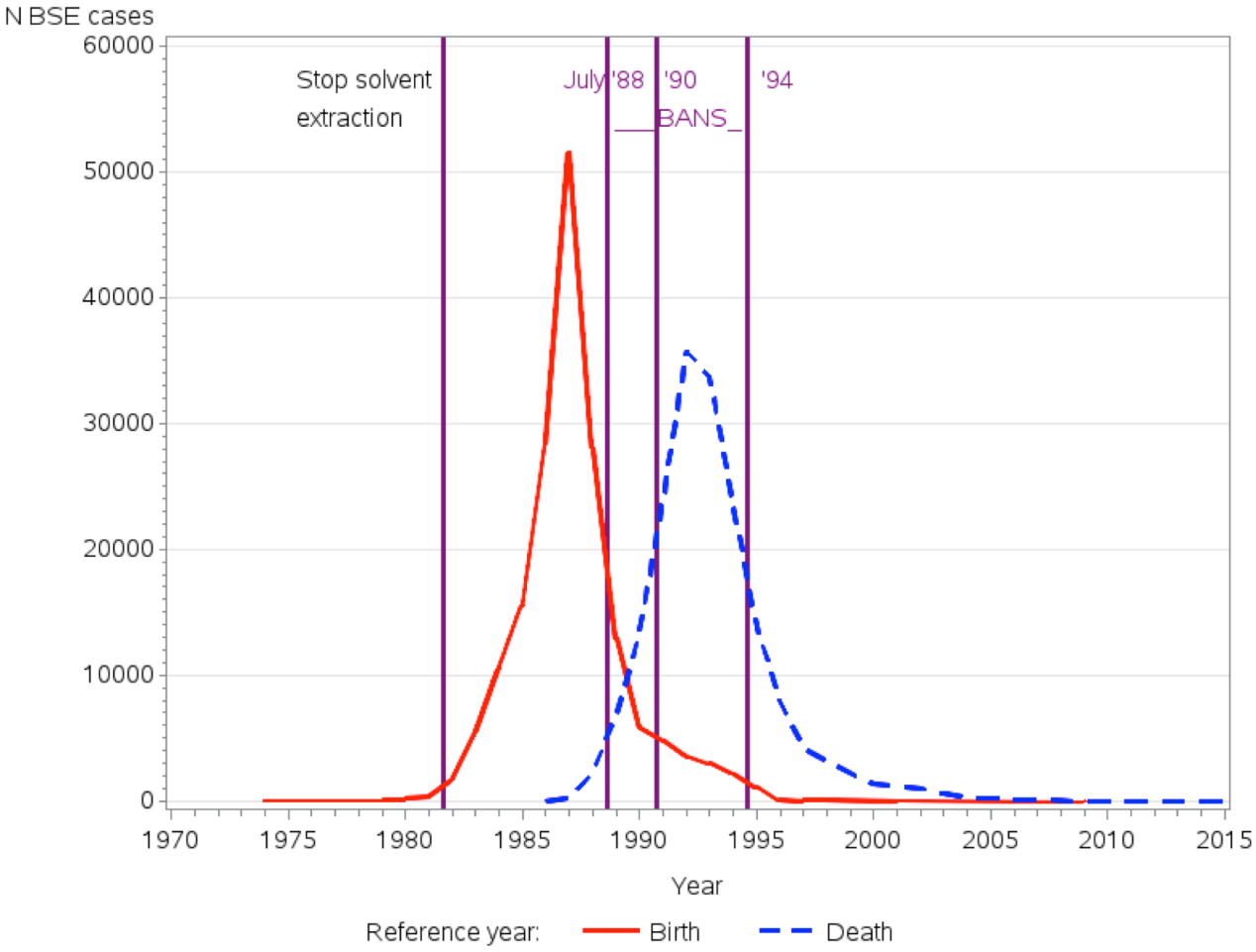

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Table 1. Reported and expected female BSE cases in the UK until 1989 by year of birth.
[*Expected cases = 8741.124354 -15376.23905*x +8548.308926*x² -2135.338811*x³ +264.9063796*x⁴ -15.97701663*x⁵ +0.379592953*x⁶*]
were x=1st to 16th year corresponding to 1974 to 1989, R^2=0.9992.

Year of birth	Average death age (years)	Reported cases (N)	Expected cases (N)
1974	17.2	3	27
1976	14.2	4	-255
1977	13.1	13	358
1978	11.7	22	220
1979	10.7	62	-219
1980	10.0	158	-273
1981	8.7	400	559
1982	7.4	1,779	2,461
1983	6.6	5,533	5,426
1984	6.1	10,548	9,664
1985	5.9	15,539	16,281
1986	5.7	28,429	28,234
1987	5.5	51,545	51,552
1988	**5.6**	**28,035**	**96,838**
1989	**5.5**	**12,955**	**181,042**